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A Tunable, Single Frequency, Fiber Ring Oscillator at 1053nm*

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Recent developments in pulse generation and modulation technology for fusion lasers have allowed for the use of low power lasers as the initial oscillator. In the Beamlet technology demonstration laser, we use a diode-pumped laser oscillator with about one watt peak output power, to generate pulses which are later amplified to about four terawatts. In the NIF, we will use fiber and waveguide optics for preamplification and modulation, with a single mode fiber ring laser as a source. This paper describes the fiber laser design and experimental results, in addition to results indicating its performance in an amplification system.

The fiber laser is based on a ytterbium-doped silica gain medium. This is pumped by a commercial 980nm laser diode, the same as those used in erbium-doped fiber amplifiers. Lasing at the 1025nm gain peak in ytterbium is prevented by signal filtering using a fiber Bragg grating, and by minimizing reflections in the cavity.

A fiber Bragg grating Fabry-Perot etalon selects a single cavity mode. Due to the ring cavity configuration, there is no spatial hole burning, and the laser operates easily on a single cavity mode. This has been confirmed by mixing the laser output with a stable single mode laser on a fast photodiode, and observing the photocurrent RF spectrum. Shifts in beat frequency indicate mode drift in the oscillator, primarily due to thermally induced changes in fiber refractive index.

The cavity length is a function of temperature through the thermo-optic effect, therefore it is stabilized using a length of fiber stretched by a piezoelectric translator. The piezoelectric is connected to a feedback circuit which monitors the laser output. The fiber gratings are also tunable by a stretching mechanism, allowing tuning of the operating wavelength over more than 4nm.

We Q-switch the laser at 1 kHz with a bulk acoustooptic modulator. The loss is controlled to allow lasing above threshold before Q-switching. This stabilizes the single mode and the pulse buildup time. The resultant Q-switched pulse is 200ns FWHM, due to the long cavity length. Peak power stability is <0.25% over 1 minute, with <3.5% stability over one hour. Long term instability is mainly due to mode hopping, which we expect to minimize with improved fiber gratings.

In the NIF design, the pulse from this ring laser will be chopped down to 30ns duration, amplified, and passed through an amplitude modulator to produce the required 20ns drive pulse.

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